# How to Convert a Satellite Dish Into a Radio Telescope

If you fancy trying your hand at radio astronomy, why not convert an old satellite dish.

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If you find yourself with an old 30 meter satellite communication antenna, what should you do with it? One option is to convert it into a radio telescope, which is exactly what astronomers at the Auckland University of Technology in New Zealand have done with an old dish lying around in the northernmost reaches of the country.

So what exactly do you have to do to convert a communications antenna into a radio telescope? Today, Lewis Woodburn at the Auckland University of Technology and a few pals, answer this question by detailing the process they have gone through to make the conversion.

The old satellite communications dish in question was built in 1984 for the New Zealand Post Office and transferred to Telecom New Zealand in 1987. By 2010, the dish had become obsolete and the company stopped maintenance with the intention of demolishing it. That's when the Auckland University of Technology stepped in.

What they inherited was a far cry from a state-of-the-art radio telescope. The dish is located near a remote township in the very north of New Zealand's North Island. Being only five kilometers from the sea, salt corrosion was significant issue, particularly given the lack of recent maintenance.

So the team's first task was to clean the dish service and replace rusty bolts and equipment. In particular, the motors that move the dish had become rusted and in any case were old and inefficient.

What's more, the dish's pointing mechanism allowed the dish to travel through only ±170° compared with the ±270° required for radio astronomy. So the power cables and metal chain that did all this steering also had to be replaced with the longer ones to allow for this extra movement. The dish also required new emergency stop circuits to prevent the dish moving beyond its mechanical limits.

Next, the team looked at the dish's control system. Originally, the antenna had a pair of large induction motors for slewing and a set of small DC servomotors with extra gearing for tracking the small daily motions of geostationary satellites. The team replaced both sets of motors with a single set of DC servomotors with optical shaft encoders that work both for slewing and tracking.

One of the challenges they came up against was designing a control system without a detailed knowledge of the antenna's mechanical characteristics, such as its stiffness, inertia, wind loads, and so on. "However, recommissioning tests showed the system to be stable with a servo accuracy of better than one millidegree under light wind conditions," say Woodburn and co. And they say that there is sufficient margin to improve the performance during gusty weather, if needed.

The team also used a laser scanner to map the shape of the reflector surface. Any serious warping could have a significant influence on the instrument's accuracy. The shape is generally satisfactory. However, "the result of data processing revealed a noticeable gravitational deformation of the antenna," say Woodburn and co. They say this is the result of the vertical elevation required to do the mapping which places the dish at an angle of just six degrees.

Knowing the exact shape should allow astronomers to allow for any gravitational deformation. However, this requires them to work out how the deformation changes with the dish's elevation, something that the team is currently working on.

Finally, they fitted the dish with the instruments necessary to detect radio waves from space. The dish has a waveguide that sends the signal into the building underneath telescope. In this area sits a new receiver designed to match one at the radio telescope at Jodrell Bank in the U.K., along with various other bits and pieces such as a recording system and an upgraded network for transmitting data and communicating with other radio telescopes when this dish operates as part of an array.

That's a handy new piece of kit that should have significant impact on the kind of radio astronomy that can be done in New Zealand. The team envisage that the dish will work both as a standalone instrument and also with other dishes as part of a radio interferometer, although some upgrading is still required. "This 30m antenna adds significantly to New Zealand's capability in radio astronomy with a large surface area and is a highly sensitive instrument capable of significant single dish work," say Woodburn and co.

Incidentally, the New Zealand dish is by no means the only satellite communication antenna converted for radio astronomy. Several similar sized dishes have been converted in Australia, Japan and Africa.

Amazing what you can do with a lump of old metal scheduled for demolition!

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